



PREPARE FOR THE NEXT PANDEMIC BY ACTIVATING THESE EARLY WARNING SYSTEMS

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Time.

It's one of the first casualties of a national emergency like a pandemic. When all too many people start getting sick and dying, the time to do something about it other than tackling the immediate emergency seems to vanish.

The time to prepare is in advance of the national emergency. In addition, we must learn to look beyond our own borders, because infectious diseases clearly don't care about lines on maps. And while none of us knows what will happen tomorrow, we do know that [we experienced a great deal—at a great cost—during the COVID-19 pandemic](#). Whether or not we **learned** lessons is debatable.

The fact is that we are swimming in data that could help provide early warning of pandemics or other high-consequence threats to human and animal health: data from millions of biometric wearable devices, signals in wastewater systems, electronic health record data systems all over the world, non-health surveillance systems (e.g., mobile and transportation data), and more, which could provide invaluable signals if effectively harnessed, analyzed, and made available in near-real time to all who can benefit.

The challenge is in gathering early warning information that already exists from systems that don't talk well with one another—and then making sense of it, in a way so decision makers feel comfortable making data-driven decisions.

Early warning gives us more time to prevent or mitigate the spread of disease from entering our borders or from spreading within the community. It gives hospitals time to prepare and to marshal resources and staff. It also gives drug makers the advance lead time to make products that can prevent or treat new or emerging diseases.

Early warning also gives us more time to think through options. For instance, during the COVID-19 pandemic we saw several national experiments that weren't thoughtfully

choreographed. We need to develop and connect these data streams in peacetime so we can intentionally ask questions during a crisis like: Do masks work? Will closing schools help or harm? Can this off-the-shelf drug be repurposed? How do we know when a new variant is in our communities already?

The following are just two examples of early warning approaches for infectious diseases that require relatively small investments to activate. While both demonstrate valuable information, they are most powerful when combined with other sources of data, such as wearables or the multiple health surveillance systems mentioned above, and viewed on both a national and an international scale.

The Canary Not in the Coal Mine

Currently, the government maintains a surveillance system across the country that captures influenza-like illness (ILI) as an early warning of potential pandemics with a respiratory disease presentation. However, the system uses a manual data entry process with up to a one- to two-week delay in aggregating and publicly sharing the data. The resulting insights may not be timely and may not be at the scale necessary for an effective early warning system.

MITRE recently ran a data experiment we called “Astute Canary,” to see what could be done to improve the representativeness and timeliness of ILI data. Recognizing that rich clinical information exists already in electronic health records (EHRs), we partnered with major EHR companies to track ILI information and were able to successfully “nowcast”

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ILI infections with the EHR data, and in doing so, have a closer to real-time picture of the national ILI situation.

Imagine if this system had been in place back in November 2019 and the information was recognized as an advanced warning of a potential pandemic (easy to say in hindsight, we realize); we might have had additional weeks to months of lead time and might have avoided the March 2020 lockdowns.

Wastewater Sampling Offers Value-Add Beyond In-Person Tests

Although it was sometimes presented as a new modality during the COVID-19 pandemic, testing of wastewater for pathogens has been around for some time and has been used to detect norovirus, hepatitis A, opioid metabolites, and even poliovirus. Recognizing that the COVID-19 virus is shed through the gastrointestinal tract, the Centers for Disease Control and Prevention established wastewater testing in all 50 states, the District of Columbia, 2 U.S. Territories, and 7 Tribal Territories, which collectively represent over 90 million people, or 27% of the U.S. population.

From a population perspective, wastewater surveillance offers a unique value-add, as it does not depend on health-seeking behavior and is less costly than clinically testing the whole population. As with the Astute Canary example, wastewater surveillance data can show patterns in targeted communities and in the case of COVID-19, in many ways, it's the only ambulatory surveillance data we have because of the use of at-home tests that go unreported, the overall decline in use of COVID-19 diagnostic tests, and the lack of reporting mandate for COVID-19 cases.

These days, some people are exploring how to better use wastewater surveillance. They are seeking to improve efficiency by reducing time and costs and enhancing decision making. The challenge is establishing the return on investment and justifying to funding appropriators that wastewater surveillance needs sustained government investment and/or defining viable commercial business models to sustain the capacity and capability through other use cases (e.g., opioid consumption, business continuity).

Other Early Warning Data Exist

Certainly, other existing or regularly collected data can be leveraged for early warning of a possible pandemic. For instance, combining mobility and transportation information with public health data could improve forecasting of disease transmission risk. And combining economic and health data could help us determine which businesses are resilient to stay-at-home orders.

Call to Action

We encourage our national and international healthcare, public health, and national security colleagues to help us take advantage of the hard-fought experiences of the COVID-19 pandemic. We cannot be complacent ... again. If we don't act before the next crisis, we could lose the gains we've made in early warning—leaving ourselves exposed to economic disruption, national security threats, and loss of life.